COARSE WOODY DEBRIS OF A PRERESTORATION SHORTLEAF PINE-BLUESTEM FOREST

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Abstract-The shortleaf pine-bluestem ecosystem was once a significant component of the Ouachita Mountains. However, fire suppression over the past century has reduced this complex. To address this loss, the Ouachita National Forest plans to restore approximately 155,000 acres of shortleaf pine-bluestem through understory, overstory, and fire treatments. We do not fully understand effects of these treatments on biotic and abiotic components of the forest. Our study of one component, coarse woody debris, is a portion of a larger study to examine ecosystem changes. Our treatments will include overstory thinning to 65 feet* per acre (approximately half that of the control), removed of the midstory and understory, and moderate intensity fires at 2- to 5-year intervals. Pretreatment values indicate total coarse woody debris volume (standing + down) did not differ between control and treatment (treatment area = 94 feet^3 per acre (SE $\pm$ 10.3); control = 110 feet^3 per acre (SE $\pm$ 46.9)), (p-value = 0.62, a = 0.05). However, due to initial differences in the woody debris components (e.g., species and decomposition class) between the pre-treatment area and control area, percent change within the pre-treatment area will be a better measure of change over time.

INTRODUCTION

Coarse Woody Debris

Coarse woody debris is important as habitat for forest organisms (Larson 1992, Maser and others 1979, Maser and others 1988, Maser and Trappe 1983, Meyer 1986, Muller and Yan Liu 1991, Thomas and others 1979, Van Lear 1993) and acts as reservoir for nutrients and carbon (Bray and Gorham 1964, Edmonds 1987, Harmon and others 1986, Lang and Forman 1978, Maser and others 1988).

Many organisms are associated with standing and down wood. Forty-five bird species use standing dead trees and 20 species use down woody debris in southern US forests (Lanham and Guynn 1996). In the southeastern US, at least 23 mammal species use standing dead trees and at least 55 mammal species use down wood (Loeb 1996). Ausmus (1977) found greater organic matter, nematode density, and root biomass in soil beneath log litter than under leaf litter. Reptiles and amphibians have been associated with coarse woody debris and their diversity may be linked with the quality and amount of coarse woody debris (Whiles and Grubaugh 1996). Earthworms may use deadwood for cover and microbial biomass as food (Hendrix 1996). Finally, Barnum and others (1992) found that mice select down logs as the most widely used substrate for travel in Minnesota and Maryland.

Ecosystem Management Research Project

The Ouachita Mountains Ecosystem Management Research Project (OEMP) is a large-scale interdisciplinary effort designed to provide the scientific foundations for watershed scale landscape management. The OEMP has progressed through three phases: developing natural regeneration alternatives to clearcutting and planting, testing these alternatives at the stand scale, and measuring cumulative impacts of landscape scale ecosystem management in the Upper Lake Winona Watershed. We divided this 16,274-acre watershed into six sub-watersheds, each with different management objectives and treatments. One of these, and the focus of this paper, is the 3,370-acre North Alum Creek sub-watershed, which is being managed to recreate a shortleaf pine-bluestem ecosystem.

The management goal is to restore a vegetation complex that existed prior to European settlement of the region. This vegetation complex was dominated by pines, primarily shortleaf (*Pinus echinata Mill*), with a minor hardwood component (mostly *Quercus* spp.) in the overstory. Frequent fires maintained a herbaceous understory dominated by bluestem grasses *(Andropogon gerardii Viaman* and *Schizachyrium scoparium* (Mich.) Nash), and restoration is designed to mimic these conditions. Treatments applied to the North Alum Creek sub-watershed will include overstory commercial thinning, midstory and understory removal, and cyclic burning.

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Over time, an area-based approach using even-aged reproduction methods, primarily two-aged shelterwoods, will achieve sustainability. Approximately 155,000 acres of shortleaf pine-bluestem ecosystems are planned to be restored on the Ouachita National Forest in Arkansas and Oklahoma.

In this study, we examine coarse woody debris (CWD) of the control area versus the proposed treatment area (defined as the pre-treatment area). Our long-term objective is to determine differences in volume and structure between the control and the restored site. The immediate objective of this study, summarized in this paper, is to compare baseline woody debris between an unharvested, unmanaged control area to the pre-treatment area.

METHODS

Future Treatment

Total basal area of the restoration treatment (65 feet^2 per acre) will be approximately half that of the control (118 feet^2 per acre). Hand lobor using chainsaws or handtools will remove the predominantly hardwood midstory and understory. We will conduct burning at 2- to 5-year intervals for 10 years, during the dormant or growing season, with moderate intensity fires. The resulting stands will be open and park-like.

Plot Layout and Measurements

We established 77 one-fifth-acre circular plots with a 52.7 ft radius, 65 plots located in the pre-treatment area and 12 in the control area. In each plot we measured both standing dead trees (snags) and down deadwood.

We measured all snags at least 4 inches d.b.h. on the fifth-acre circular plot. For each tree we recorded species, d.b.h., and height. We recorded five decay classes for hardwood trees and six classes for pines (table 1). These classes are:

(1) recently dead with tight bark, twigs and small branches present;

(2) dead, small branches broken, bark - loose and/or partly absent;

(3) dead, mostly large branches present, bark - trace to absent;

(4) dead with bark absent: broken top; heavily decayed; soft, blocky structure (a 6-inch knife blade can be easily inserted 3 inches or more into the wood);

(5) soft and powdery or down (for snags this is a post-treatment measurement only);

(6) (Pine only): all but heartwood has decayed and fallen away.

For down wood ≥4 inches in diameter, in fifth-acre plots we measured length and midpoint diameter (figure 1). We recorded branches larger that 4 inches in diameter as separate pieces indicated by numbered segments (figure 1).

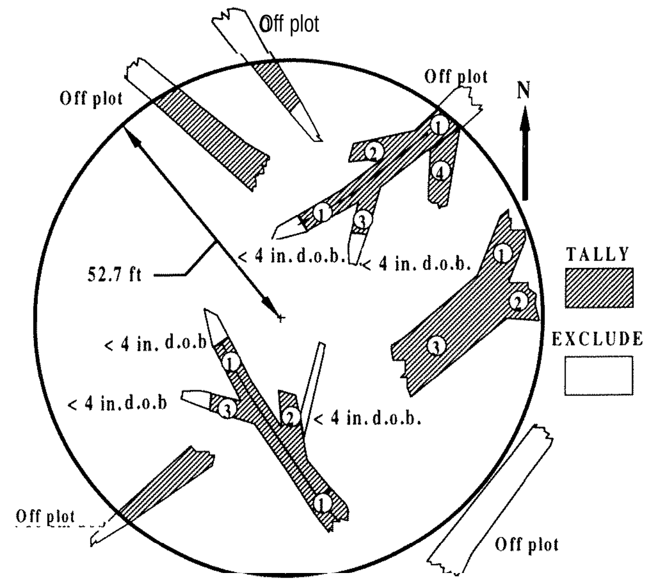

Figure 1-A typical fifth-acre circular plot. We measured all down deadwood ≥ 4 inches in diameter on the plot. Numbered segments were measured separately. Additionally, all standing dead trees (snags) ≥ 4 inches d.b.h. were measured on the plot (snags not pictured).

We calculated snag volume as:

$$V = 1/3 \times H \times [B + B' + \mathrm{sqrt}(B \times B')]$$

Where: V = volume in ft^3

H = height of tree main stem (ft)

B = cross sectional area of tree at dbh (ft^2)

B' = cross sectional area at the top of the stem (ft^2)

We calculated down deadwood volumes (feet^3) as length of segment multiplied by the midpoint cross sectional area. We compared mean volume of course woody debris between plots in the pre-restoration and control area plots using a one way ANOVA, alpha 0.05.

RESULTS

Total coarse woody debris volume (standing snag + down wood) was similar, with 110 feet^3 per acre in the control and 94 feet^3 per acre in the pre-treatment area. These values did not differ statistically (p-value = 0.62, a = 0.05) (figure 2). However, pine snag volume in the control plots was nearly double that of pre-treatment plots (figure 3). For down deadwood of pine, just the opposite was true, with a mean of 2.4 feet^3 per acre in the control plots versus 13.7 feet^3 per acre in pre-treatment plots.

Decomposition class 3 of the pine snag component in the control area had greater mean volume than any other class (figure 4). Class 4 dominated the pine down deadwood component in both the control and pre-treatment area (figure 5).

DISCUSSION AND CONCLUSIONS

Surprisingly decomposition class 5 was rarely recorded on our plots, although nearly all previous studies have shown this as a major component. However, class 5, often hidden

Table l-Breakdown of decomposition classes for snags and down wood. Decomposition class 1 represents the least decomposed woody material and class 5 is the most decomposed woody material. Adapted from Cline and others (1980) and Maser and others (1979)

		Decomposition class				
Dead-wood type	Characteristic	1	2	3	4	5
Snags	Branches and Crown	recently dead, twigs and small branches present	large branches present, mostly broken	large branch stubs present	absent	NA
	Bark	tight	loose and/or partly absent	trace to absent	absent	NA
	Bole	recently dead	standing, firm	standing, decayed	broken top, heavily decayed, soft, blocky structure	NA
Down wood	Bark	intact	intact	trace to absent	absent	absent
	Twigs > 1.2 in.	present	absent	absent	absent	absent
	Texture	intact	intact, sapwood partly soft	hard, solid interior, possible evidence of exterior decay	soft, blocky pieces	soft and powdery
	Shape	round	round	round	round to oval	oval
	Color of wood	original color	original color	original color to faded	original color to faded	heavily faded
	Portion of log on ground	log elevated on support points	log elevated on support points	log near or on ground	all of log on ground	all of log on ground

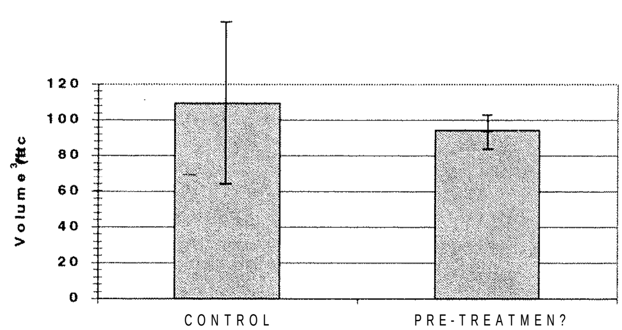

Figure 2-Total mean volume of standing plus down deadwood. Error bars represent standard error.

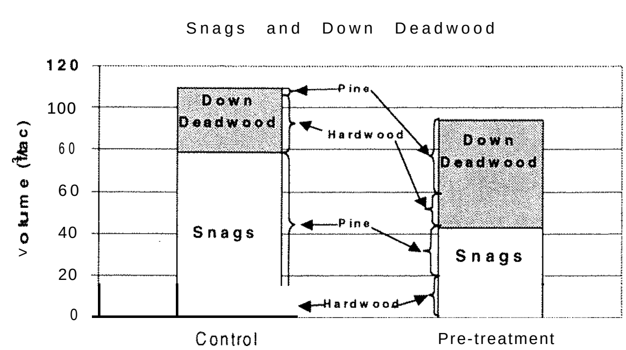

Figure 3-Snags and down deadwood volume (feet³ per acre) by pine or hardwood in control and future treatment area.

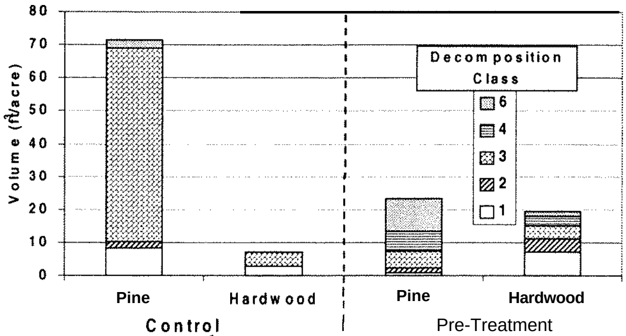

Figure 4-Mean volume of snags by species and decomposition class in control versus future treatment area. We used decomposition class 5 only for down deadwood.

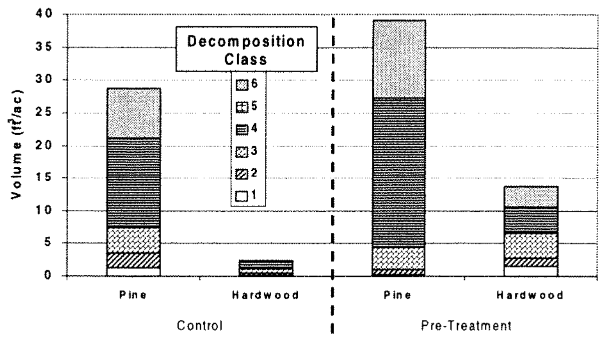

Figure 5-Mean volume of down deadwood by species and decomposition class in control versus future treatment area. Note that class 5, found only for pine on the pre-treatment area, was 0.1 feet^3 per acre.

under leaves, is the most difficult to detect. We plan to re-sample some plots to examine the possibility of undersampling. If not a sampling error, then this result would require closer examination of the dynamics and interacting organisms in the class 4 stage and beyond.

Other studies have found intermediate decay classes, such as our class 3, tending to be dominant (Harmon and others 1986, Shifley and others 1997, Spetich and others 1999, Spies and Cline 1988). However, only the pine snag component in the control area showed this relationship. Decomposition class 4 currently represents the largest volume when compared to the other decomposition classes.

For decomposition class 6 resin-impregnated pine is highly flammable, and the fire treatment will likely reduce its volume.

Post-treatment comparisons of deadwood volume in this study will require testing total deadwood volume changes between the control and treatment areas. Due to initial differences or high variability in the components (e.g. hardwood versus pine and decomposition class) between the treatment and control areas, percent and rate of change will be a better measure of comparison over time.

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